REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
20-02-2013	Final	

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
03-2-830A Stability Test of Indirect Fire Artillery Weapons

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 03-2-830A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Range Infrastructure Division (CSTE-TM)
US Army Test and Evaluation Command
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10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT

Distribution Statement A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.:

This TOP supersedes TOP 03-2-830, Cold Regions Stability Test of Indirect Fire Artillery Weapons, dated 30 June 1976.

Marginal notations are not used in this revision to identify changes, with respect to the previous issue, due to the extent of the changes.

14. ABSTRACT
This TOP prescribes methods for determining the stability of indirect fire weapons fired from varied terrain types incurred in all climatic zones. Requirements for facilities and test instrumentation are included.

15. SUBJECT TERMS
self-propelled weapons, towed weapons, natural environment, artillery, cannon, indirect fire, stability.

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**B. ABSTRACT**	**C. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	SAR	20	

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 03-2-830A 20 February 2013
DTIC AD No.

STABILITY TEST OF INDIRECT FIRE ARTILLERY WEAPONS

*This TOP supersedes TOP 03-2-830, Cold Regions Stability Test of Indirect Fire Artillery Weapons, dated 30 June 1976.

1. SCOPE.

The procedures specified in this Test Operations Procedure (TOP) are designed to allow evaluation of the stability of cannon type artillery weapons during firing from terrain under varying conditions including; subarctic, tropic, desert and temperate climatic areas. Artillery weapons, due to their extreme recoil forces, can have adverse affects on the lay of the system, and often requires re-laying of the system after a few rounds being fired. Knowing the limitations of the systems will give the user a greater understanding of where to emplace, and the limitations of using a less than favorable position. This TOP is limited to towed and self-propelled weapons employed in the indirect fire mode. Due to differences in emplacement techniques, mortar stability testing is not included.

2. FACILITIES AND INSTRUMENTATION.

a. Typical facility requirements are listed below.

Item	Requirement
Firing range	A controlled access firing range.
Impact area	Impact area usable from minimum high angle to maximum range of the test weapons.
Firing positions	Soil types to be tested (breakdown listed in Tables 1-3): Subarctic: Snow-covered ground, Non-glazed ice, Muskeg, and Glacial Riverbed. Tropic: Saturated (swampy) ground, level savannah (sandy) ground, level grassy. Desert: Fan terraces, alluvial fans or open flood plains consisting of Riverbend Family-Carizzo Family Complex, Cristobal Family-Gunsight Family Complex, and the Gunsight Family-Chuckawalla Family Complex soil types. Temperate: As determined by the Test Officer. Each climatic zone should also be fired from the following; forward and reverse slopes of 5, 10, and 15 percent; and 10 percent left and right cant.

Item	Requirement
Observation Post (OP)	A minimum of four OPs which can observe the predicted impact point of each round.
Survey control	Survey control at each OP and firing position (1:3000 accuracy).
Electrical power	Electrical power at OPs and firing positions with sufficient capacity for co-located instrumentation and auxiliary equipment. Power and instrumentation cables at the firing position protected from damage.
Environment	Environmental and fragmentation protection (bomb proofs and blast shields) for test personnel. Utilize electrical heat sources whenever possible to minimize ice fog.
Communications	Radio and/or wire telephone communications between all OPs, firing positions, and test control/fire direction center. Having both modes of communications allow a redundant system. If available, the use of wire telephone communications is preferred in order to minimize interference with test instrumentation.
Storage areas	Secure storage areas for the test weapon(s) and ammunition components. The degree of required environmental protection will be specified in the requirements documents.

b. Typical instrumentation requirements are provided below.

Devices for Measuring	Permissible Measurement Uncertainty
Survey Equipment (Digital theodolites or aiming circles)	0 to 360 degrees; ± 0.01 degree 0 to 6400 mil; ± 1 mil
Powder thermometer	-55 to +40 °Celsius (C); ± 1 °C
Muzzle velocity radar	42 to 1200 meters/second; ± 4 meters/second
Measuring tape	0 to 10 meters (m); ± 0.5 centimeters (cm)
Weight scales	0 to 100 kilogram (kg); ± 1 gram (g)

Devices for Measuring	Permissible Measurement Uncertainty
High Speed (HS) video	400 frames/second
Standard video system	125 frames/second
Meteorological support	
Ambient air temperature	-55 to +40 °C; ± 1 °C
Wind velocity	0 to100 knots; ± 2 knots
Wind direction	0 to 360 degrees; ± 2 degrees
Relative humidity	5 to 95 percent; ± 5 percent
Radar and wind (RAWIN) (upper air)	120 percent maximum ordinate at two-hour intervals

c. Typical personnel requirements are provided below.

Quantity	Personnel Needed
Suitable number for test weapon being fired	Gun crew
2	Geodetics personnel
1	Muzzle velocity radar operator
2	HS and regular videographer
2	Wiebel tracking radar operator
1	Copper crusher reader
4	Observation post operator
2	Data collector
1	Safety Officer
2	Ammunition Handler
1	Test Officer
1 (if available)	Test Non-Commissioned Officer (NCO)

3. REQUIRED TEST CONDITIONS.

3.1 Planning.

a. Manned-weapon firing will not be conducted unless a safety release and waiver to conduct manned firing has been approved. Applicable range and safety Standard Operating Procedures (SOPs) will be followed during testing.

b. All ammunition components fired, to include accuracy and precision firing tests, will be from the same lot number.

c. All personnel will wear the appropriate protective clothing for the environment. If military personnel are required, ensure a Test Schedule and Review Committee (TSARC) request is submitted within one year from the start of testing or as early as possible.

d. Firing ranges will correspond to those used for accuracy and precision firing for comparison of results.

3.2 Facilities.

Ensure that facilities meet the requirements specified in paragraph 2.a.

3.3 Equipment.

Inspect the test weapon for completeness and serviceability. Ensure that the associated sighting and boresighting equipment is complete and serviceable. Ensure that sufficient ammunition and components are available for test completion.

3.4 Instrumentation.

Ensure that all required test instrumentation (reference paragraph 2.b) is available, in operational condition, and calibrated. Arrange for meteorological support, to include RAWIN (upper air) data at two-hour intervals beginning one hour prior to firing the first round and until one hour after last round. Upper air readings can be in meteorological computer ballistic message (MET CM) or MET ballistic message (B) format.

4. TEST PROCEDURES.

a. After a complete inspection of the weapons system and ammunition, conducting a proper geodetic surveying layout of gun position (safety fans, line of fire, etc). Emplace and lay the weapon with center of traverse directly over the gun position survey point and the tube pointing in the primary direction of fire at a firing position which satisfies one of the terrain conditions described in Tables 1 through 4. Place out aiming posts.

TABLE 1. SUBARCTIC TERRAIN CONDITION USE BY SEASON

CONDITION	SEASON		
	BREAKUP	SUMMER	WINTER
Snow-covered ground, level			X
Nonglazed ice, level			X
Muskeg, level	X	X	X
Glacial riverbed, level	X	X	X
Glacial riverbed, 5, 10, and 15 percent forward slope			X
Glacial riverbed, 5, 10, and 15 percent reverse slope			X
Glacial riverbed, 10 percent right and left cant			X

TABLE 2. TROPIC TERRAIN CONDITION USE BY SEASON

CONDITION	SEASON	
	SUMMER	WINTER
Level saturated (swampy) ground	X	X
Level savannah (sandy) ground	X	X
Level level grassy	X	X
5, 10, and 15 percent forward slope	X	
5, 10, and 15 percent reverse slope	X	
10 percent right and left cant	X	

TABLE 3. DESERT TERRAIN CONDITION USE BY SEASON

CONDITION	SEASON	
	SUMMER	WINTER
Level Riverbend Family-	X	
Level Carizzo Family Complex	X	
Level Cristobal Family	X	
Level Gunsight Complex Family	X	
Level Chuckawalla Family	X	
5, 10, and 15 percent forward slope	X	
5, 10, and 15 percent reverse slope	X	
10 percent right and left cant	X	

TABLE 4. TEMPERATE TERRAIN CONDITION USE BY SEASON

CONDITION	SEASON	
	SUMMER	WINTER
Level Ground Type as determined by Test Officer.	X	X
5, 10, and 15 percent forward slope	X	X
5, 10, and 15 percent reverse slope	X	X
10 percent right and left cant	X	X

b. A minimum of two topographic instruments will be located to the rear of the weapon, one directly behind it to establish a triangulation baseline and the other set up over a Survey Control Point (SCP).

c. Place a minimum of two contrasting marks on the non-moving portion of the weapon carriage as far apart as possible, which can be seen by digital theodolites or aiming circles at all deflection and elevation settings of the weapon. With the instrument behind the weapon, shoot a back azimuth to the already oriented instrument over the SCP and line up the weapon to the required azimuth of fire.

d. Install the muzzle velocity radar at the test weapon.

e. Verify test weapons boresight before and after firing each group.

f. Prepare a minimum of eight complete rounds of ammunition utilizing the maximum charge zone, in addition to the number of warm-up and seating rounds determined from precision fire exercises.

g. After tube warm-up, fire eight rounds at two-minute intervals at center of traverse and with the elevation corresponding to maximum range of the weapon.

h. Measure muzzle velocity of each round.

i. Adjust weapon to commanded quadrant elevation and deflection after each round.

j. Determine aiming post displacement after each round (if displacement exceeds sight correction limits record displacement, relay weapon, and continue firing).

k. Measure and record horizontal and vertical angles to all weapon reference marks from each survey instrument prior to firing and after firing each round.

l. Observe and record any unusual incidents during firing.

m. Observers at OPs will observe the impact of each round and report any abnormalities (duds, low order bursts, etc.). Impact locations will be determined and recorded using all observer data in a standard Universal Transverse Mercator (UTM) X, Y, and Z format.

n. Plot the observed impact of each round in real time.

o. Record ambient temperature, two-meter wind velocity and wind direction, relative humidity, precipitation, and visibility for each group.

p. Check boresight after each group, record any corrections.

q. Re-emplace the weapon with center of traverse in primary direction of fire and repeat paragraphs 4.a through 4.o at maximum quadrant elevation less 10 mils.

r. Re-emplace the weapon with center of traverse in primary direction of fire and repeat paragraphs 4.a through 4.o at quadrant elevation of 300 mils.

s. Repeat paragraphs 4.a through 4.q except that the weapon will be layed with primary direction of fire at the right traverse limit less 10 mils.

t. Repeat paragraphs 4.a through 4.q with primary direction of fire at the left traverse limit less10 mils.

u. Repeat paragraphs 4.a through 4.s for each of the conditions described in Tables 1 through 4.

5. DATA REQUIRED.

5.1 Test Weapon.

Record the nomenclature, model numbers, serial numbers, general condition, damage and discrepancies, documentation photographs, lot numbers of all weapons components, ammunition components, and projectile weight zones.

5.2 Instrumentation.

Record the type, nomenclature, serial numbers, range, accuracy, calibration due date, application, and location.

5.3 Facilities.

Record the surveyed locations of OPs and firing points and orienting angles.

5.4 Test Personnel.

Record the names, rank, military occupational specialty (MOS), experience, assigned duties, and degree of proficiency.

5.5 Meteorological Support.

Record the equipment range accuracies.

5.6 Data Recorded.

a. Record the following data for each group fired. A sample data sheet is included in Appendix A.

(1) Terrain and season (reference Table 1).

(2) Length of triangulation base and initial horizontal and vertical angles to weapon reference marks.

(3) Horizontal and vertical angles to weapon reference marks after completion of group.

(4) Total aiming post displacement after firing group.

(5) Average powder temperature.

(6) Ambient weather conditions before and after each group.

(7) Ammunition lot numbers.

(8) Surveyed locations of OP and weapon.

(9) Quadrant elevation, weapon traverse position, and azimuth of fire.

(10) Meteorological corrections for range and deflection.

b. Record the following data for each round fired. A sample data sheet is included in Appendix A.

(1) Tube Round Number (TRN)

(2) Horizontal and vertical angles to impact from each OP.

(3) Corrections required to re-lay weapon.

(4) Aiming post displacement.

(5) Horizontal and vertical angles to weapon reference marks after each round.

(6) Muzzle velocity.

(7) Video recordings of selected rounds.

(8) Unusual occurrence or incidents observed at firing position or impact area.

6. PRESENTATION OF DATA.

6.1 Data Reduction.

a. Calculate center of impact and dispersion for each group.

b. Calculate the weapon displacement for each round, using the horizontal and vertical angles measured to the weapon reference marks and triangulation computation methods.

c. Reduce the muzzle velocity radar data to the actual muzzle of the weapon.

d. Edit and annotate the video recordings.

6.2 Data Presentation.

a. Summarize comments by test personnel and present in narrative format.

b. Present the test conditions, weapon and aiming post displacement, and impact data in tabular form.

c. Upload edited and annotated video recordings to the Versatile Information Systems Integrated On-Line (VISION) Digital Library System (VDLS).

APPENDIX A. SAMPLE DATA SHEETS.

STABILITY TEST OF
ARTILLERY WEAPONS AND FLASH BASE DATA

SUBTEST NUMBER: _____

OBSERVATION POST:
NAME _____INSTRUMENT TYPE _____ANGLES IN MILS _____DEGREES _____

COORDINATES: NORTHING _____ EASTING _____ ALTERNATE _____

ORIENTATION DATA:
NUMBER 1 - NAME _____ HORIZONTAL ANGLE _____ VERTICAL ANGLE _____
NUMBER 2 - NAME _____ HORIZONTAL ANGLE _____ VERTICAL ANGLE _____

ROUND NUMBER	HORIZONTAL ANGLE	VERTICAL ANGLE
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		

APPENDIX A. SAMPLE DATA SHEETS.

STABILITY TEST OF ARTILLERY WEAPONS

WEAPON DISPLACEMENT DATA

SUBTEST NUMBER _____								
INSTRUMENT NUMBER _____ TYPE _____								
ROUND NO.	POINT NUMBER 1		POINT NUMBER 2		POINT NUMBER 3		POINT NUMBER 4	
Initial Angle	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

APPENDIX A. SAMPLE DATA SHEETS.

STABILITY TEST OF ARTILLERY WEAPONS

DATA SUMMARY

SUBTEST NUMBER _____

TERRAIN TYPE _____ SLOPE _____ DATE _____ AIR TEMPERATURE _____

WINDSPEED (2M) ___ DIRECTION ___ RELATIVE HUMIDITY ___ GROUND CONDITION _____

AMMUNITION LOT:
PROJECTILE _____ POWDER _____ FUZE _____ PRIMER _____ POWDER TEMPERATURE _____

QUADRANT ELEVATION _____ AZIMUTH OF FIRE _____ TRAVERSE _____

WEAPON DISPLACEMENT							
ROUND	MUZZLE VELOCITY	VERTICAL, cm	LATITUDE, cm	LONGITUDE, cm	YAW, degrees	ROLL, degrees	AIMING POST DISPLACEMENT, mils
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

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APPENDIX B. ABBREVIATIONS.

B	ballistic
C	Celsius
cm	centimeter
CM	computer ballistic message
g	gram
HS	high speed
kg	kilogram
m	meter
MET	Meteorological
mil	A unit of angular measurement used in artillery equal to one sixty-four hundredths of a complete revolution
MOS	military occupational specialty
NCO	Non-Commissioned Officer
OP	Observation Post
RAWIN	radar and wind
SOP	Standard Operating Procedure
TOP	Test Operations Procedure
TRN	Tube Round Number
TSARC	Test Schedule and Review Committee
UTM	Universal Transverse Mercator
VDLS	Vision Digital Library System
VISION	Versatile Information Systems Integrated On-Line

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APPENDIX C. APPROVAL AUTHORITY.

CSTE-TM 22 February 2013

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, US Army Evaluation Center
US Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 03-2-830A, Stability Test of Indirect Fire Artillery Weapons, Approved for Publication

1. TOP 03-2-830AStability Test of Indirect Fire Artillery Weapons, has been reviewed by the US Army Test and Evaluation Command (ATEC) Test Centers, the US Army Operational Test Command, and the US Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

The procedures specified in this TOP are designed to allow evaluation of the stability of cannon type artillery weapons during firing from terrain under varying conditions including; subarctic, tropic, desert and temperate climatic areas. Artillery weapons, due to their extreme recoil forces, can have adverse affects on the lay of the system, and often requires re-laying of the system after a few rounds being fired. Knowing the limitations of the systems will give the user a greater understanding of where to emplace, and the limitations of using a less than favorable position.

2. This document is approved for publication and has been posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at https://vdls.atc.army.mil/.

3. Comments, suggestions, or questions on this document should be addressed to US Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), US Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Test Management Office (TEDT–YPC–TM), US Army Cold Regions Test Center, PO Box 31350, Fort Greely, AK 99731. Additional copies can be requested through the following website: http://itops.dtc.army.mil/RequestForDocuments.aspx, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.